

## Meiofauna communities from the Straits of Magellan and the Beagle Channel\*

G. T. CHEN<sup>1</sup>, R. L. HERMAN<sup>1, 2</sup> and M. VINCX<sup>1</sup>

<sup>1</sup>Marine Biology Section, Department of Biology, University of Gent, Ledeganckstraat 35, B-9000 Gent, Belgium.

E-mail: [guotong.chen@rug.ac.be](mailto:guotong.chen@rug.ac.be)

<sup>2</sup>present address: Science Policy Administration, Brussels, Belgium

**SUMMARY:** Meiofauna from 20 stations (ranging between 8 and 550 m) in the Magellan Straits and the Beagle Channel revealed 28 small sized taxa of higher categories including the temporary meiofauna. Nematoda, Copepoda Harpacticoida and Polychaeta occurred in all samples; Turbellaria, Bivalvia, Kinorhyncha and Ostracoda were regularly present. Nematodes represented between 68% and 94% of the meiofauna at each station, followed by the copepods (2.3% to 14.5%) and polychaetes (1.1% to 11.5%). Maximal total density, 9700 individuals 10 cm<sup>-2</sup>, was found in the surroundings of Picton Island, while the mean abundance per station was 3374 individuals 10 cm<sup>-2</sup>. The vertical pattern within the sediment showed that 87% of meiofauna components concentrated in the upper 0-5 cm sediment layers and 13% in the lower (> 5cm) layers. More than 95% of copepods, as well as the temporary meiofauna occurred in the top 5 cm layers. The proportion of nematodes and copepods shows opposite trends in the vertical distribution. Multivariate analysis using the total density and the 10 'true' meiofauna taxa densities discriminates between communities in the Straits of Magellan and the Beagle Channel area. Meiofaunal density was much higher in the Beagle Channel, but the diversity was lower than that in the Straits of Magellan. The Southern Magellan meiofauna communities are compared with those found at the Antarctic Peninsula and in the Weddell Sea (high Antarctic). It is considered that hydrodynamic features (tidal currents with strong winds), geographical characteristics, together with sediment composition are the key parameters structuring the meiofauna community in the Straits of Magellan and in the Beagle Channel.

**Key words:** Meiofauna, Density, Community, Straits of Magellan, Beagle Channel, Antarctic.

**RESUMEN:** COMUNIDADES DE MEIOFAUNA DEL ESTRECHO DE MAGALLANES Y DEL CANAL DEL BEAGLE. – La meiofauna de 20 estaciones (extendiéndose entre 8 y 550 m) en el Estrecho de Magallanes y el Canal del Beagle reveló 28 taxones de tamaños pequeños de categorías más altas incluyendo la meiofauna temporal. Nematoda, Copepoda Harpacticoida y Polychaeta estuvieron presentes en todas las muestras; Turbellaria, Bivalvia, Kinorhyncha y Ostracoda estuvieron regularmente presentes. Los nemátodos representaron entre 68% y 94% de la meiofauna en cada estación, seguidos por los copépodos (2,3% a 14,5%) y los poliquetos (1,1% a 11,5%). La densidad total máxima, 9700 individuos/10 cm<sup>2</sup>, fue encontrada en los alrededores de la Isla de Picton, mientras que la abundancia promedio por estación fue de 3374 individuos/10 cm<sup>2</sup>, incluyendo la meiofauna temporal. El modelo vertical dentro del sedimento mostró que 87% de las componentes de la meiofauna se concentraron en las capas superiores del sedimento de 0-5 centímetros y 13% en las más bajas (> capas de los 5 cm). Más del 95% es de los copépodos así como la meiofauna temporal aparecieron en las capas superiores de 5 centímetros. La proporción de nemátodos y de copépodos muestra una tendencia opuesta en la distribución vertical. El análisis multivariante usando la densidad total y las 10 densidades 'verdaderas' de los taxones de la meiofauna discrimina las comunidades en el Estrecho de Magallanes y del área del Canal del Beagle. La densidad de la meiofauna fue mucho más alta en el Canal del Beagle, pero la diversidad fue menor que en el Estrecho de Magallanes. Las comunidades meridionales de la meiofauna del Estrecho de Magallanes fueron comparadas con las encontradas en la Península Antártica y en el Mar de Weddell (alta Antártida). Se considera que las características hidrodinámicas (corrientes de marea con vientos fuertes), características geográficas, junto con la composición del sedimento, son los parámetros claves que estructuran la comunidad de la meiofauna en el Estrecho de Magallanes y en el Canal del Beagle.

**Palabras clave:** Meiofauna, densidad, comunidad, Estrecho de Magallanes, Canal del Beagle, Antártida.

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## INTRODUCTION

During 17 October to 25 November 1994 the Chilean-German-Italian R.V. 'Victor Hensen' Campaign was carried out in the Straits of Magellan and the Beagle Channel. The Straits of Magellan is a narrow channel, about 500 km long which crosses the Sub-Antarctic region of the South American continent, separates Patagonia from Tierra del Fuego and connects the Atlantic and Pacific Oceans (Brambati and Colantoni, 1991). Tides are the most significant hydrodynamic feature in the Straits of Magellan, the highest spring amplitudes in the Atlantic entrance are about 9.0 m; in the central and western basins, tides are of a mixed type, predominantly semidiurnal and mean amplitudes are 1.1 m (Medeiros and Kjerfve, 1988). The mean annual air temperature is 6°C on the Pacific side, 2°C in winter season. Surface water salinity ranges from 32.5-28.0 psu.; for most of the areas the salinity is about 30.8 psu. (Brambati *et al.*, 1991; Panella *et al.*, 1991). The Straits of Magellan is close to the Antarctic and the exchange between the southern tip and the Antarctic is supposed to have been more frequent and longer lasting than between other fragments of Gondwana (Arntz and Gorny, 1996).

Only few reports of quantitative information on the meiofauna communities from the Antarctic have been published so far (Arntz *et al.*, 1994; Bovée, 1977; Bouvy and Soyer, 1989; Herman and Dahms, 1992; Vanhove *et al.*, 1995, 1998). In this paper, the results of a quantitative meiofauna study in the Magellan Region are reported, including higher taxonomic community structures and environmental factors influencing the meiofauna distribution. A comparison is made of the meiofauna communities between the Straits of Magellan, the Beagle Channel, the Antarctic Peninsula and the Weddell Sea.

## MATERIAL AND METHODS

Meiofaunal samples were collected from 20 stations, of which 11 stations were located in the Straits of Magellan and 9 stations in the Beagle Channel, during the R.V. 'Victor Hensen' Joint Magellan Campaign 1994 (Table 1, Fig. 1). The bottom samples were obtained with the multicorer (MUC) which causes little disturbance during sediment sampling. Subsamples for meiofauna studies (up to 5 replicates and each of 10 cm<sup>2</sup> of the surface area) were taken from each station. The sediment samples

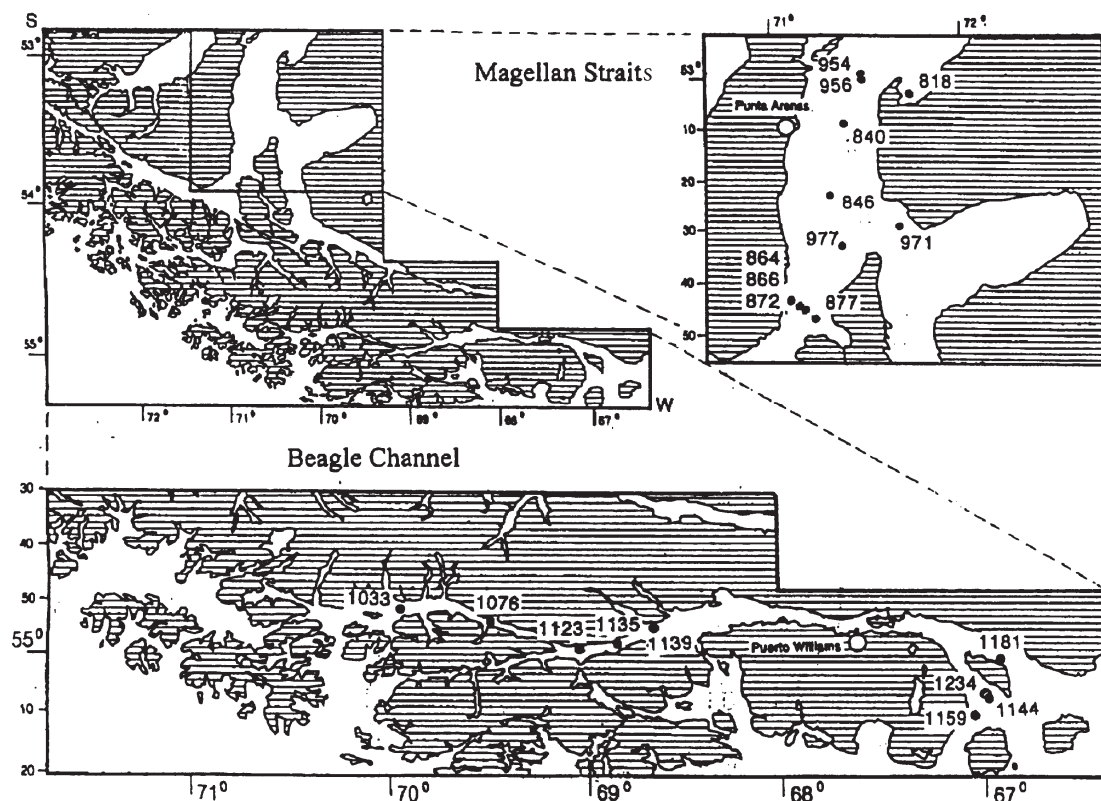


FIG. 1. – Location of the 20 meiofauna sampling stations (solid circles and station numbers) in the Straits of Magellan and the Beagle Channel.

TABLE 1. – Location of sampling stations and their sedimentological features in the Straits of Magellan and the Beagle Channel.

Station No.	Date	Lat. S	Long. W	Depth (m)	Median ( $\mu\text{m}$ )	Sand % ( $>63 \mu\text{m}$ )	Silt % (4–63 $\mu\text{m}$ )	Clay % ( $<4 \mu\text{m}$ )
818	19-Oct-94	53°02'6	70°17'2	8	33.9	8.2	80.0	11.7
840	23-Oct-94	53°08'8	70°38'4	123	28.5	22.3	59.4	18.3
846	23-Oct-94	53°21'6	70°43'3	195	65.4	51.0	39.9	9.2
864	25-Oct-94	53°42'6	70°48'7	550	17.2	20.2	57.9	22.0
866	25-Oct-94	53°41'8	70°54'6	440	13.0	11.9	65.2	23.0
872	25-Oct-94	53°43'4	70°56'0	351	17.3	23.9	52.6	23.6
877	25-Oct-94	53°41'5	70°56'5	227	55.6	-	-	-
954	31-Oct-94	52°59'7	70°33'0	79	149.6	77.0	13.4	9.6
956	31-Oct-94	52°59'9	70°32'9	80	195.2	91.6	4.4	4.0
971	01-Nov-94	53°28'9	70°21'9	90	-	-	-	-
977	01-Nov-94	53°33'0	70°39'2	459	8.6	2.0	67.8	30.2
1033	04-Nov-94	54°52'7	69°55'2	309	8.0	1.0	72.3	26.7
1076	05-Nov-94	54°53'6	69°30'3	346	15.1	7.2	75.0	17.8
1123	06-Nov-94	54°58'7	69°01'9	219	11.2	8.0	67.7	24.3
1135	07-Nov-94	54°55'0	68°49'9	257	7.0	0.0	67.5	32.5
1139	07-Nov-94	54°55'0	68°39'2	255	11.0	6.6	71.8	21.6
1144	08-Nov-94	55°08'4	66°54'5	110	7.5	0.0	66.2	33.8
1159	10-Nov-94	55°08'0	67°01'9	32	-	-	-	-
1181	12-Nov-94	55°07'0	66°55'4	110	5.3	0.0	58.9	41.1
1234	18-Nov-94	55°00'4	66°53'6	100	8.9	0.0	70.2	29.8

were divided into two sections, i.e. the top layer (0–5 cm) part and the below 5 cm layer, and were fixed with warm formaldehyde to a final concentration of 4 %.

The meiofauna samples were treated in the laboratory by passing through a 1 mm mesh sieve and retaining on a 38  $\mu\text{m}$  sieve. A density-gradient centrifugation technique (Ludox HS 40 %) was used to extract the meiofauna from the silty sediments (Heip *et al.*, 1985). Meiofauna counting and classification into higher taxa was carried out directly under the stereomicroscope (Leica WILD M8).

Two-way indicator species analysis (TWINSPAN, Hill, 1979) was used to determine the similarity of the station groups. The CANOCO program (Canonical Correspondence Analysis, Ter Braak, 1988) was used for the ordination which reflects the major relations between the meiofauna taxa and/or stations and their environmental parameters. Sediment granulometry was examined by means of a Coulter LS 100 instrument.

Hill's diversity indices (Hill, 1973) were calculated based on the density of meiofauna taxa, as follows:

$N_o = S$ , (number of meiofauna taxa)

$N_1 = \exp(H')$ , where  $H' = -\sum p_i \ln p_i$ , ( $H'$  = Shannon-Wiener index)

$N_2 = 1/SI$ , Where  $SI = \sum p_i^2$ , (Simpson's dominance index)

$N_{inf} = 1/p_1$ , ( $p_1$  is the proportion of the most dominant taxon)

Spearman Rank correlation coefficients and regres-

sion methods were used to determine the correlation between meiofauna density, diversity and environment variables.

## RESULTS

### Sediment granulometric analyses

The data of sediment granulometric analyses are shown in Table 1. The sediments at the stations in the Beagle Channel (stations 1033–1234) were very homogeneous and characterized by low median grain size (less than 15  $\mu\text{m}$ ) and high clay-silt contents (90–100%). Sediment components in the Straits of Magellan (stations 818–977) were more diverse, the median grain size varied from 8.6 to 195.2  $\mu\text{m}$ , the percentages of clay-silt ranged from 8.4 % (station 956) to 91.7% (station 818), the sand content was highest at station 956 (91.6%), and more than 20% of sand contents were found at the stations 840, 846, 864 and 872.

### Composition of the meiofauna

Twenty-eight higher taxa (ranging from 9 at station 818 and 22 at station 872) of meiofauna were found in the investigated area and resulted in a mean taxa number of 16 per station (Table 2). Nematodes, copepods (including nauplii) and polychaetes were found at all sites; the relative abundance of these three main taxa represented about 97.0 % in total of the meiofauna community. Bivalves, kinorhynch,

TABLE 2. – Average densities of true meiofauna taxa (A) and temporary meiofauna taxa (B) in the Straits of

Taxa\Station	818	840	846	864	866	872	877	954	956	971	977	1139	1033	1076
Copepoda*	187.5	83.5	139	100.3	295	303.7	223.4	134.5	91	84	300.3	292.4	92	140.5
Gastrotricha	-	2.5	-	1	0.5	0.3	0.3	6.5	3.5	-	0.7	-	0.3	-
Halacaroida	-	-	-	-	-	0.7	-	0.5	-	-	-	3.7	0.7	-
Kinorhyncha	2	4	84.7	6	5.5	15	41.7	20	4	6	17.3	20.7	10	20.5
Loricifera	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nematoda	1424.5	980	1664.3	2038.3	1383.5	1880.7	3137.7	1567.5	1029.5	1475	2497.7	4426.7	2417.7	3547.5
Ostracoda	-	-	10	5	10	17.7	12.3	8	1.5	4	20.7	17.7	2	2.5
Rotifera	-	-	-	-	-	0.3	-	4	3	17	1.3	-	1.7	-
Tardigrada	-	-	-	-	-	1	-	-	0.5	-	-	-	0.7	0.5
Turbellaria	3	1	7.7	38	30.5	7.7	25	-	42.5	2	51.3	5.7	9.7	18.5
Subtotal	1617	1071	1905.7	2188.6	1725	2227.1	3440.4	1741	1175.5	1588	2889.3	4766.9	2534.8	3730
<b>B.</b>														
Taxa\Station	818	840	846	864	866	872	877	954	956	971	977	1139	1033	1076
Amphipoda	1	2	3.3	0.7	1.5	0.3	0.7	1.5	4	1	-	4	0.3	1
Aplacophora	-	-	1.3	4.7	14	4.7	1	-	-	-	3.3	1.7	0.7	0.5
Bivalvia	1	30	17.7	18.3	36	31.3	20.3	21.5	16.5	8	28	19	7	27
Bryozoa	-	-	-	-	-	-	-	-	-	-	-	-	0.3	-
Cladocera	-	-	-	0.3	-	1.3	-	-	-	-	-	-	1	-
Cumacea	-	2.5	-	2	3.5	1.3	0.7	-	-	1	0.3	2	2.3	2
Echiurida	-	-	0.3	-	0.5	0.7	-	-	-	-	-	-	-	-
Gastropoda	-	-	-	-	-	-	0.3	-	3.5	-	0.7	-	-	1
Echinodermata	0.5	1.5	-	0.7	0.5	0.7	-	0.5	-	-	0.3	0.3	-	-
Hydrozoa	2	0.5	4	9.7	11	17	1.3	-	-	4	18.3	4.7	0.3	2
Isopoda	-	-	-	-	-	-	0.3	-	-	1	-	-	0.3	1.5
Nemertina	-	-	-	-	-	0.3	-	-	0.5	-	1.7	2	-	-
Oligochaeta	-	1	2	5.3	2.5	17.7	9.3	5	4	1	9.7	3.7	2	5
Polychaeta	67	58.5	89.3	140.7	235	122	83.7	102	83	61	141.7	118.7	27.3	100
Priapulida	-	3.5	-	0.3	1	1.3	1.7	-	-	-	0.7	-	1.3	-
Sipunculida	-	0.5	-	-	2.5	-	0.3	-	-	-	-	4	-	-
Tanaidacea	-	1	3.3	1.7	3.5	3	2.3	2	0.5	2	1	3	1.3	13
Tunicata	-	-	-	-	-	-	-	-	-	2	2.3	2.3	-	-
Subtotal	71.5	101	121.2	184.4	311.5	201.6	121.9	132.5	112	81	208	165.4	44.1	153
Total	1689	1172	2027	2373	2037	2429	3562	1874	1288	1669	3097	4932	2579	3883

\* including nauplii

oligochaetes and turbellarians occurred at 19 stations, amphipods, hydrozoans, ostracods and tanaidaceans were found at 17 to 18 stations.

The overall average meiofauna density at all stations was  $3374 \pm 571$  ind.  $10\text{ cm}^{-2}$  and ranged from  $1172 \pm 335$  ind.  $10\text{ cm}^{-2}$  (station 840) to  $9682 \pm 1774$  ind.  $10\text{ cm}^{-2}$  (station 1234) (Table 2 and Fig. 2). The maximum density in one replicate was 11624 ind.  $10\text{ cm}^{-2}$ . The mean density in the Straits of Magellan ( $2110$  ind.  $10\text{ cm}^{-2}$ ) was obviously lower than that in the Beagle Channel ( $4920$  ind.  $10\text{ cm}^{-2}$ ).

Nematodes were the most abundant taxon and the average density was  $2945 \pm 676$  ind.  $10\text{ cm}^{-2}$  which contributed 87.3 % of the meiofauna. The lowest densities of nematodes occurred at station 840 ( $980 \pm 291$  ind.  $10\text{ cm}^{-2}$ ) and station 956 ( $1030 \pm 129$  ind.  $10\text{ cm}^{-2}$ ). The relative abundance varied from 67.9% (station 866) to 93.7% (station 1033). The highest densities of nematodes were found in the surroundings of Picton Island, with the maximum of 8552 ind.  $10\text{ cm}^{-2}$  at station 1234.

Copepods were the second dominant taxon (210 ind.  $10\text{ cm}^{-2}$ ) and represented 6.2 % of relative abundance of meiofauna. The highest density of copepods occurred also at station 1234 ( $633$  ind.  $10\text{ cm}^{-2}$ ). Although the average density of copepods in the

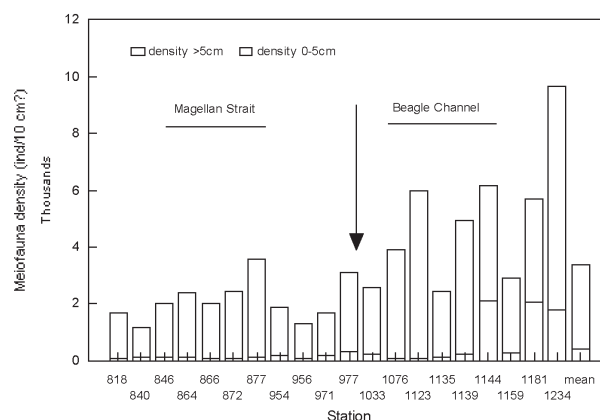


FIG. 2. – Distribution of mean meiofauna densities at 20 stations in the Straits of Magellan and the Beagle Channel.

1123	1135	1144	1159	1181	1234	Mean	±SE
288.5	56.7	313	161	278.7	633.3	209.9	29.2
1.5	-	0.7	-	4	3.5	1.3	0.4
1	1.5	-	-	-	-	0.4	0.2
103.5	7.7	9.3	-	15	128	26.1	7.8
-	-	-	-	-	0.5	0.0	0.0
5418	2245.7	5581.7	2536	5100	8552.3	2945.2	424.0
14.5	3.5	5.7	45	9.7	15.5	10.3	2.2
2	1.5	0.7	-	-	-	1.6	0.8
-	-	-	-	0.7	-	0.2	0.1
10.5	18.7	39	39	47.7	34.8	21.6	3.7
5839.5	2335.3	5950.1	2781	5455.8	9367.9	3216.6	454.3
1123	1135	1144	1159	1181	1234	Mean	±SE
5.5	1	2.7	7	-	-	1.9	0.4
2	2.5	-	-	-	-	1.8	0.7
32	3.7	8	-	4.3	9.5	17.0	2.4
-	-	-	2	-	-	0.1	0.1
1	-	-	-	-	-	0.2	0.1
5.5	-	0.7	2	0.7	-	1.3	0.3
-	-	-	-	-	-	0.1	0.0
-	-	-	-	-	-	0.3	0.2
0.5	0.5	0.7	-	-	-	0.3	0.1
15	3.7	-	3	0.3	0.8	4.9	1.3
1.5	-	-	-	1	-	0.3	0.1
-	-	1.3	-	-	-	0.3	0.1
4.5	6.3	6	7	5.7	6.5	5.2	0.9
83.5	78	188.3	115	200.3	286.5	119.1	14.0
3.5	1	8	-	5.3	10.5	1.9	0.6
3	3	1	-	0.7	-	0.8	0.3
5.5	0.5	-	4	-	0.5	2.4	0.6
-	-	-	-	-	-	0.3	0.2
163	100.2	216.7	140	218.3	314.3	158.2	15.6
6003	2431	6167	2919	5674	9682	3374.0	463.5

Beagle Channel (251 ind. 10 cm<sup>-2</sup>) was higher than in the Straits of Magellan (177 ind. 10 cm<sup>-2</sup>), the relative abundance was higher in the Straits of Magellan (8.4 %) than in the Beagle Channel (5.1 %).

Polychaetes were the third important taxon of meiofauna with a mean density of 119 ind. 10 cm<sup>-2</sup> and 3.5 % of the relative abundance. The proportion of polychaetes was higher in the Magellan Straits, although there was no big difference in the average density between the Straits of Magellan (108 ind. 10 cm<sup>-2</sup>) and the Beagle Channel (133 ind. 10 cm<sup>-2</sup>). Polychaetes were most important at station 866 and represented 11.5 % of the individuals at this station. The highest density of polychaetes occurred at station 1234 (287 ind. 10 cm<sup>-2</sup>).

The mean density of temporary meiofauna bivalves was higher in the Straits of Magellan (21 ind. 10 cm<sup>-2</sup>) than in the Beagle Channel (11 ind. 10 cm<sup>-2</sup>). Kinorhynchs had a mean density of 26 ind. 10 cm<sup>-2</sup>, and were more abundant in the Beagle Channel (37 ind. 10 cm<sup>-2</sup>) than in the Straits of Magellan

(19 ind. 10 cm<sup>-2</sup>). A pronounced high density of kinorhynchs occurred at three stations, i.e., station 846 (85 ind. 10 cm<sup>-2</sup>), station 1123 (104 ind. 10 cm<sup>-2</sup>) and station 1234 (128 ind. 10 cm<sup>-2</sup>). Turbellarians, ostracods, oligochaetes and hydrozoans were commonly distributed in the whole area and the mean densities were 22, 10, 5 and 5 ind. 10 cm<sup>-2</sup>, respectively. The other rare taxa were mainly the larvae of macrobenthos (temporary meiofauna), such as echinurids, gastropods, isopods, nemerteans, priapulids, sipunculids, tunicates and echinoderms, which all occurred in very low individual numbers, and contributed only about 1.0 % of relative abundance of the total.

The total density of meiofauna decreased with increasing water depth in the Beagle Channel ( $p \leq 0.01$ ), whereas a positive correlation was found between total density and water depth in the Straits of Magellan ( $p \leq 0.05$ ). The abundance of aplousophorans, hydrozoans, cumaceans, echinurids and tanaidaceans were all increased with water depth. Bivalves showed highly positive correlation with the % of sand ( $p \leq 0.01$ ).

It can be concluded that meiofauna taxonomic composition is very different between the Straits of Magellan and the Beagle Channel with the proportion of nematodes being clearly higher in the Beagle Channel, whereas the proportion of copepods, polychaetes and other taxa is higher in the Straits of Magellan.

### Vertical distribution of meiofauna

On the average of all stations, 87 % of the meiofauna components concentrated in the upper 5 cm sediments. 91 % of the polychaetes occurred in the upper 5 cm layers. Most meiofauna taxa (copepods and all temporary meiofauna) occurred for more than 95 % of their relative abundance, or even exclusively in the upper layers.

The densities in the lower sediment sections (>5 cm) ranged from 100-200 ind. 10 cm<sup>-2</sup> at most stations. Three stations in the eastern mouth of the Beagle Channel (stations 1144, 1181 and 1234), however, presented very high mean densities of about 2000 ind. 10 cm<sup>-2</sup> in the low sediment parts, which represents 34 %, 37 % and 18 % of the total relative abundance of the meiofauna in these stations, respectively.

It is also interesting to note that the proportion of nematodes in the total abundance of meiofauna is higher in the lower sediment layer (> 5 cm, 94.0 %)



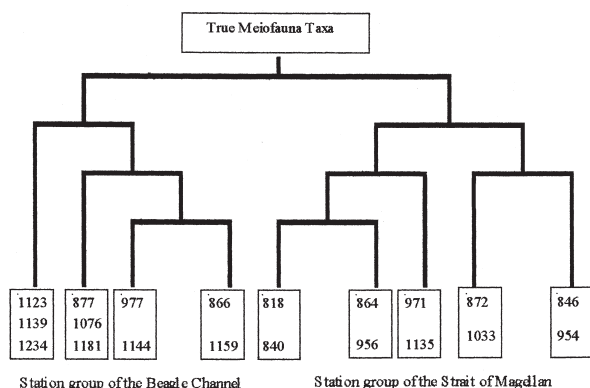


FIG. 3. – Dendrogram of TWINSpan classification of the meiofauna communities in the Straits of Magellan and the Beagle Channel

than in the upper layer (0-5 cm, 86.3 %), but the proportion of copepods shows the opposite trend (6.8 % in 0-5 cm, 2.5 % in > 5 cm sediment).

### Multivariate analysis of the meiofauna community

Figure 3 shows the result of the TWINSpan computed using the densities of 10 permanent meiofauna taxa. The meiofauna samples are divided into two main groups which principally separate the Beagle Channel stations from the Straits of Magellan stations, although a few stations appeared in the other group (stations 866, 877 and 977 occurred in the Beagle Channel group, stations 1135 and 1033 occurred in the Straits of Magellan group). The result of CANOCO (with squareroot transformation of the densities of the 10 meiofauna taxa) shows more or less the same patterns as the TWINSpan: two groups of sampling stations were distinguished

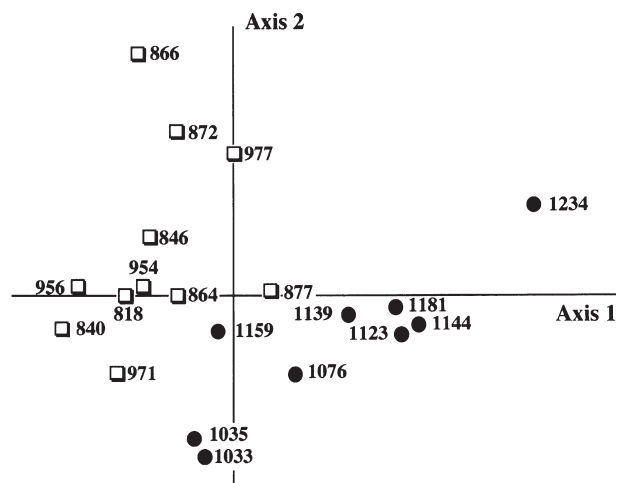


FIG. 4. – Canonical Correspondence Analyses along the two main axes based on the 'true meiofauna' densities for the 20 stations from the Straits of Magellan (●) and the Beagle Channel (□).

(Fig. 4) which are the same as two geographical areas between the Magellan Straits and the Beagle Channel. The first axis (eigenvalue 0.88) is mainly correlated with the amount of silt and the stations of the Beagle Channel distributed along this axis, whereas the second axis (eigenvalue 0.04) is mainly correlated with the water depth and creates the largest distinction in the stations of the Magellan Straits.

### Diversity of the meiofauna community

The diversity indices  $No$ ,  $N_1$ ,  $N_2$ ,  $Ninf$  and  $H'$  at each of the stations are shown in Table 3. In general, diversities are clearly higher in the Straits of Magellan than at the stations of the Beagle Channel, except for the number of taxa  $No$ . Results of the

TABLE 3. – Diversity indices (Hill's numbers  $N_0$ ,  $N_1$ ,  $N_2$ ,  $Ninf$  and Shannon-Wiener index  $H'$ ) of the meiofauna community in the Straits of Magellan

A. Station	818	840	846	864	866	872	877	954	956	971	977	1033	1076	1123
No	9	15	13	17	18	22	18	13	15	15	19	21	16	21
N1	1.74	1.99	2.12	1.88	2.96	2.38	1.73	1.99	2.29	1.72	2.21	1.39	1.54	1.62
N2	1.38	1.41	1.46	1.35	2.01	1.62	1.28	1.41	1.54	1.27	1.51	1.14	1.20	1.22
Ninf	1.19	1.20	1.22	1.16	1.47	1.29	1.14	1.20	1.25	1.13	1.24	1.07	1.09	1.11
H'	0.55	0.69	0.75	0.63	1.08	0.87	0.55	0.69	0.83	0.54	0.79	0.33	0.43	0.48
B. Station	818	840	846	864	866	872	877	954	956	971	977	1033	1076	1123
No	8	14	12	16	17	21	17	12	14	14	18	20	15	20
N1	2.16	4.39	4.81	4.99	4.15	4.39	4.53	4.36	5.12	4.90	4.73	4.75	5.07	5.33
N2	1.76	3.25	3.76	3.52	2.94	2.75	3.01	3.17	3.84	3.36	3.13	2.75	3.58	3.33
Ninf	1.41	2.30	2.61	2.38	2.21	1.80	1.90	2.28	2.84	2.31	2.00	1.75	2.39	2.03
H'	0.77	1.48	1.57	1.61	1.42	1.48	1.51	1.47	1.63	1.59	1.55	1.56	1.62	1.67

TABLE 4. – Comparison of the meiofauna communities between Halley Bay, Kapp Norvegia, Signy Island (all Antarctic) and the present study area.

Location	Halley Bay Herman and Dahms, 1992	Kapp Norvegia Vanhove, 1997	Present study	Signy Island Vanhove <i>et al.</i> , 1998
Water depth (m)	500-2000	211-2080	8-550	7-9
Total taxa number	28	24	28	11
Taxa per station	10.8	11	16	
Density range (ind./10 cm <sup>2</sup> )	792-3119	811-5122	1172-9682	4900-13200
Mean density (ind./10 cm <sup>2</sup> )	1677		3374	9000
Nematoda (ind./10 cm <sup>2</sup> )	1578 (94.1 %)	1857 (82.5-96.4%)	2945 (87.3%)	7500(83.3%)
Harpacticoidea (ind./10 cm <sup>2</sup> )	50 (3.0%)	71	175 (5.0%)	1300(14.4%)
Kinorhyncha (ind./10 cm <sup>2</sup> )	20 (1.2%)	17	26 (0.8%)	
Polychaeta (ind./10 cm <sup>2</sup> )	11 (0.7%)	17	119 (3.5%)	
V.D.* (0-5cm)	97.4%		87.4%	
V.D. (>5cm)	2.6%		12.6%	

\* Vertical distribution

diversity calculated without nematodes show that station 818 has clearly the lowest value of all the diversity indices. Five stations in the eastern mouth of the Beagle Channel (including station 1139) are lower in diversity indices  $N$ ,  $N_2$  and  $H'$ . Thus, the higher dominance of nematodes in the Beagle Channel results in an overall lower diversity here as compared with the Magellan Straits. The number of taxa is strongly correlated with depth (Spearman rank  $p < 0.001$ ), and the diversity indices, except for  $N_0$ , are negatively correlated with the silt content ( $p < 0.05$ ).  $N_1$  and  $H'$  are positively correlated with % of sand ( $p < 0.05$ ).

## DISCUSSION

### Comparison with the Antarctic area

The number of higher meiofauna taxa in this study is very similar to Kapp Norvegia and the Halley Bay area in the Weddell Sea (Herman and

Dahms, 1992; Vanhove *et al.*, 1995; Vanhove, 1997). Nematodes, copepods, polychaetes and kinorhynchs are the dominant taxa in both study areas. However, the overall mean density and number of taxa per station is higher in the Straits of Magellan and the Beagle Channel (Table 4). Furthermore, Polychaetes were found more abundant in the Straits of Magellan and the Beagle Channel than in the Weddell Sea.

Compared with the coastal waters of the Antarctic Peninsula (Signy Island, water depth 7-9 m, Vanhove *et al.*, 1998), with densities in the range of 4900-13200 ind. 10 cm<sup>-2</sup> and a mean of 9000 ind. 10 cm<sup>-2</sup>, densities are much lower in the Beagle Channel and the Magellan Straits.

Kinorhynchs seem to be more dominant in very silty sediments both in Halley Bay and in the Beagle Channel (stations 1123 and 1234), although they also occurred in quite large numbers at the sandy station 846.

In the Halley Bay area, about 97 % of the total meiofauna is restricted to the upper 5 cm sediment layer; this indicates that in the Weddell Sea only 3 % of meiofauna lives in the lower sediment layers. In the Straits of Magellan and the Beagle Channel, however, the relative abundance of meiofauna in the lower sediment layer varies between 2-10 % at the most of the stations, whereas in the eastern mouth of the Beagle Channel, a pronounced proportion of the meiofauna (30%) inhabits the deeper layers. These clay-silt stations at a depth of 100 m also contained a high number of taxa (8-9 taxa per station) in the deeper layers.

### Meiofauna community and its environment

Bouvy and Soyer (1989) studied the meiofauna abundance in an intertidal mudflat at Kerguelen

and the Beagle Channel. A. including nematodes; B. without nematodes

1135	1139	1144	1159	1181	1234	Mean	± SE
17	18	16	11	15	13	16.10	0.73
1.50	1.61	1.54	1.80	1.58	1.65	1.86	0.08
1.17	1.23	1.22	1.32	1.23	1.27	1.36	0.04
1.08	1.11	1.10	1.15	1.11	1.13	1.17	0.02
0.41	0.47	0.43	0.59	0.46	0.50	0.60	0.04
1135	1139	1144	1159	1181	1234	Mean	± SE
16	17	15	10	14	12	15.1	0.73
5.53	4.03	3.44	4.45	3.63	3.41	4.41	0.17
3.67	2.53	2.53	3.46	2.73	2.55	3.08	0.11
2.43	1.73	1.87	2.39	2.06	1.78	2.12	0.08
1.71	1.39	1.24	1.49	1.29	1.23	1.46	0.05

Islands, and found the mean nematode percentages lower in the oxidized layer than under the redox potential discontinuity (RPD) layer; for copepods, however, higher abundances were found in the oxidized layer and lower ones under the RPD layer. This phenomenon indicates that copepods are more sensitive to decreased oxygen, but nematodes have the capability of tolerating hypoxic or even anoxic conditions (Coull, 1988; Ott and Schiemer, 1973). Although the RPD layer is not determined in this study, this tendency is observed also in the Straits of Magellan and the Beagle Channel, where the relative abundance of nematodes and copepods between the upper 0–5 cm and deeper than 5 cm sediment layers showed the opposite trend.

As stated by Dinert (1979), Thiel (1979), Snider *et al.* (1984), Shirayama (1984), Pfannkuche (1985), Soetaert *et al.* (1991), Vincx *et al.* (1994) and many others, meiofauna abundance and density decreases with increasing water depth. This negative relationship between water depth and the abundance of meiofauna is caused mainly by surface productivity and the distance from land (Bovée *et al.*, 1990). This phenomenon, however, does not exist in the Straits of Magellan. In fact, lowest meiofauna densities were found in localities with a water depth shallower than 100 m. The Magellan Straits is a channel ecosystem, where the distance from land is always short as compared to the open ocean.

Erosion, transport and redeposition of sediments are major sources of physical disturbance for soft-sediment habitats and associated benthic communities, during periods with very strong currents, resulting in greatly reduced abundance of all size categories of organisms (Aller, 1989; Thistle *et al.*, 1985). Tides and currents are the main hydrodynamic features in channel environments. Tidal current velocities were recorded up to  $4.5 \text{ m s}^{-1}$  at the narrow passages of Primera and  $3.0 \text{ m s}^{-1}$  at Segunda Angostura (Medeiros and Kjerfve, 1988). Michelato *et al.* (1991) reported a maximum speed of  $20 \text{ cm s}^{-1}$  for the near-bottom (189 m) current in the centre of Paso Ancho. On the other hand, currents are also generated or strengthened by the predominantly westerly winds, strong winds up to  $27 \text{ m s}^{-1}$  are common during winter and spring, in correspondence with the influx of air masses of Antarctic (Medeiros and Kjerfve, 1988; Panella *et al.*, 1991; Brambati and Colantoni, 1991). A wind speed of about  $50 \text{ km h}^{-1} = 14 \text{ m s}^{-1}$  will result in a mixed layer of 67 m depth and a surface current of  $20 \text{ cm s}^{-1}$  (Figueroa and Yuras, 1996). Palmer and

Gust (1985) reported that transport of meiobenthos was primarily a passive process resulting from mechanical removal due to current scour. This physical process is typically dominant in the upper few centimetres (0–5 cm or even up to 10 cm) of the sediment, where most of the meiofauna is living. There is no doubt that meiofauna in the water column comes from sediments during resuspension, and that meiofauna is highly under predation pressure. Gutt and Schickan (1996) found the richest epibenthic species associations in terms of abundance and biomass in the shallow areas (approx. 15–130 m) in the Straits of Magellan. It is interesting to note that the lowest meiofauna densities were found in the same depth range, which may suggest that the lower abundance of meiofauna at the shallow water stations ( $< 100 \text{ m}$ ) is most likely the result of removal by the strong tidal currents and high predation pressure in the Straits of Magellan.

Diaz *et al.* (1994) stated that activities of benthic organisms combined with physical processes can alter primary structures of fine-grained sediments. In the sediment accumulation area, infaunal communities are well developed with high abundance and biomass, and the surface sediments are completely dominated by biogenic structures created by the activities of a deep burrowing infauna. The meiofauna density in the Beagle Channel is much higher than that in the Straits of Magellan. The stations with the highest meiofauna densities (stations 1144, 1184 and 1234) have clay-silt sediment textures, which indicates this area to be a low energetic and sedimentation environment where a huge amount of fine particles with organic matter and detritus is settled down (Brambati *et al.*, 1991). These rich food sources may support an abundant meiofauna community as has also been reported for the Arctic and the Antarctic (Pfannkuche and Thiel, 1987; Vanhove *et al.*, 1995). Bovée *et al.* (1990) reported temporal variability of meiofauna abundance in relation to seasonal fluxes of organic matter into the benthos. The meiofauna density tends to increase in finer sediment with more “available resources” as e.g. deposited organic matter which represents the major food source for the mainly deposit-feeding meiofauna (Thiel, 1983; Vanreusel *et al.*, 1992). It is, therefore, supposed that the abundant meiofauna populations occurring in the lower sediment layers of the Beagle Channel, are related to sedimentation and sediment structure. We also found quite a high density of Copepoda harpacticoidea ( $> 90 \text{ ind. } 10 \text{ cm}^{-2}$ ) in the deeper layers at these localities.



A decrease of diversity with increasing environmental fluctuations has been observed by Ott and Machan (1971). Station 818 is 8 m depth and has the lowest diversities which might thus be affected by strong tidal currents in the Straits of Magellan. Warwick *et al.* (1991) stated that the most important environmental variables controlling or affecting the distribution and abundance of benthic animals in estuaries are salinity and several interrelated sediment variables (grain size, organic content), which in turn are determined by the hydrodynamic features of the estuary. The Straits of Magellan is a special area which is influenced strongly by the tidal currents. The hydrodynamics do not only affect meiofauna through their effects on environmental variables, but also influence the stability of the sediment and the nature of the food supply. The eastern mouth of the Beagle Channel has high sedimentation which results in food enrichment, thus creating a unique environment for the meiofauna community. Both the TWINSPAN (Fig. 3) and the ordination (Fig. 4) illustrate that grouping of the stations largely covers their geographical distribution in the Straits of Magellan and in the Beagle Channel. The hydrodynamic features (tidal current and frequent western winds), together with the sediment composition, are the most important environmental factors influencing meiofauna distribution in this highly dynamic system.

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